THE WHALE SHARK (*RHINEODON TYPUS* SMITH) IN INDIAN COASTAL WATERS.

WITH NOTES ON ITS WANDERINGS IN OTHER AREAS.

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(*With* 1 *map and* 7 *plates*).

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INTRODUCTION.

The Whale Shark (*Rhineodon typus*), the largest of existing sharks, grows to a length of over 50 ft. It ranges through the tropical and sub-tropical waters of the Pacific, Indian and Atlantic Oceans. Mr. E. W. Gudger (1934) has brought together, from numerous sources, records of whale sharks, captured or seen in the wide area of their distribution. As regards the coastal waters of India, his paper adds considerably to the single record noted by Day in his volume on Fishes in the *Fauna of British India* series. Enquiries subsequent to the capture of a whale shark off the Ratnagiri coast in October 1938, have enabled me to add a number of new records to the list made by Gudger. The following notes on the occurrence and distribution of whale sharks in the coastal waters of India include previous records noted by

Gudger, supplemented with the data now made available. I have numbered the records in the order in which they are listed in the table which appears on p. 260.

Distribution of the Whale Shark in Indian Coastal Waters.

West Coast of India.

Sind.

No. 1. In his introductory note to the Order, Selachoidea, Day (1889) refers to Dr. Buist's (1850) note on shark-fishing at Karachi, where an export trade in sharks' fins was then, and is yet carried on. Dr. Buist describes the methods employed in the capture of a 'basking shark', known to the local fishermen as the *mhor*, which is usually found floating or asleep on or near the surface of the sea. Dr. Buist's informant told him that the *mhor* is often 40 to 60 ft. in length, with a capacious mouth reaching 4 ft. in width. As a result of enquiries made at Karachi, I ascertained that fishermen still know of a fish called *mhor* which, as Buist describes, is occasionally harpooned while basking on the surface of the sea. My correspondent was unable to give any figures as to the actual number of *mhor* caught. He was told by the fishermen that in some years they took several of these sharks and in others they were not seen at all, but as a *mhor* realised about Rs. 15 from the oil obtained from its liver, it was hardly worthwhile making special efforts to capture them.

The question arises what species of shark is known as the *mhor*?

Gudger (loc. cit.) commenting on Buist's description of the general characters and habits of the fish concludes that the *mhor* is none other than the whale shark. He says:—

> 'though no mention of spots is made, its gigantic size and cavernous mouth would seem to make it the Whale Shark, which like *Cetorhinus*, the true Basking Shark, is frequently found at the surface of the water. Further more *Cetorhinus*, which has a comparatively small mouth, has (so far as I know) never been taken in the North Indian Ocean. It is primarily a cold water shark. The Mhor must have been the Whale Shark'.

While Buist made no reference to spots—an obvious and striking character in the colouration of the whale shark—the term *mhor*, the local name for the fish, is in itself descriptive of this character (vide notes on local names p. 270). Apart from this, actual confirmation of Gudger's views as to the identity of the *mhor* is now obtained by the recent captures of so called 'Basking Sharks' at Karachi, which proved to be whale sharks.

The history of these captures is as follows:—

No. 2. Mr. B. D. Ashworth, in a letter to the *Times of India*, (kindly forwarded to me by the Editor) enclosed two photographs of a Whale Shark caught at Karachi in April 1932. The fish was harpooned by fishermen from a small boat and, after a protracted struggle, was brought under control and killed with an axe. The axe marks on the fish's head can be seen in the photo (Plate II, No. 1).

No. 3. On the 27th March 1937, Capt. Heygate of the 1st Bttn., Royal West Kent Regiment and Lt. Heirsch, Royal Scot's Fusiliers harpooned a whale shark, 18 ft. in length, off Cape

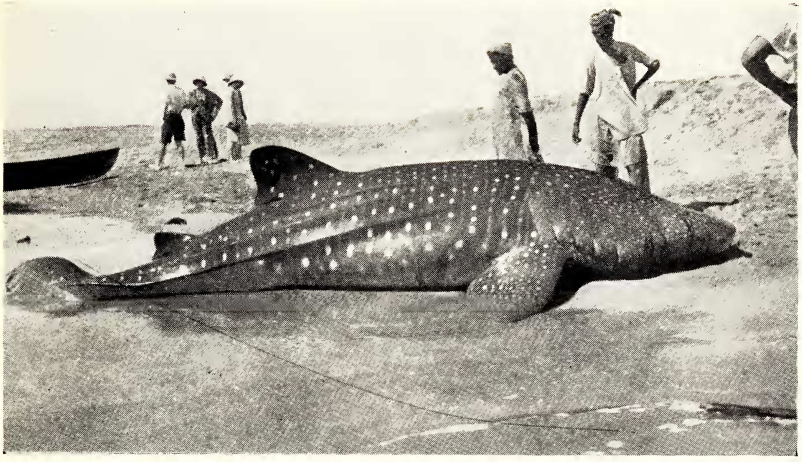
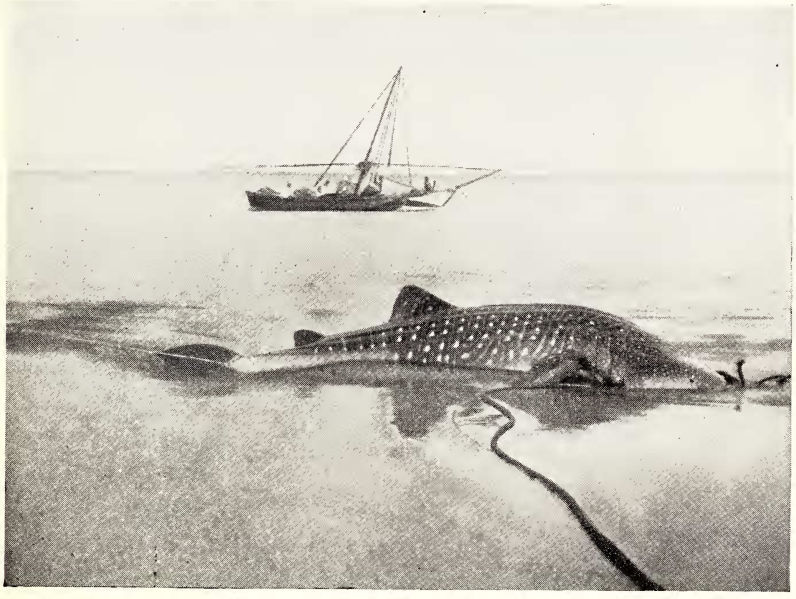


Photo by *B. D. Ashworth.*

1. Whale Shark caught at Karachi, April, 1932.



2. Whale Shark (18 ft.) harpooned by Capt. Heygate and Lt. J. L. Heisch off Cape Monze, Karachi, 27th March, 1937.

Photo by P. K. Gogote *The Times of India.*

Whale Shark (20 ft.) caught in the fishing nets near Jaygad, Ratnagiri, Bombay Province, on 3rd October, 1936.

Monze, some 20 miles north of Karachi. The shark was towed into Karachi harbour. The photo shows the fish after it was beached (Plate II, No. 2).

No. 4. In April of the same year, the two officers named above, harpooned a scond specimen some three miles off Karachi. The harpoon worked loose and the fish got away. They were however able to get a good view of the shark, when it was swimming on the surface of the sea, and again when beneath their boat. They state, in a note sent to me, that it was identical with their first capture having the 'same spotted skin and spade-shaped head'.

Bombay Province.

No. 5. On October 3rd, 1936, a whale shark, caught in the fishing nets near Jaygad, Ratnagiri, about 100 miles south of Bombay, was brought ashore by the fishermen. Mr. P. K. Gogote, the local correspondent of the *Times of India,* sent a photograph of the fish to this paper with a note saying that the fish was over 20 ft. in length. He adds—

> 'the special feature of this fish was that it could not be cut, i.e. the cut effected showed no trace owing to the rejoining of the skin'.

Owing to the elasticity of the skin and the deep underlying layers of fat, any incisions made in the body of this fish rapidly close up and leave little or no trace. The unexpected result so impressed the fisherfolk, that they returned the fish to the sea rather than be held accountable for its life. Mr. Gogote says that it was towed into deep water and released 'owing to superstitious fears.' A photo of the fish, originally published in the *Times of India,* is reproduced here. (Plate III).

No. 6. On Sunday, February 13th, 1938, a whale shark, 21′ 6″ in length, was caught by fishermen 15 miles from Bombay. It had fouled their nets and was towed into Sassoon Dock, Bombay. I was informed of the capture of this fish by Dr. S. B. Setna, Fisheries Officer, Bombay. When we arrived at the dock a great crowd of people had already assembled round the shark, which had been dragged up the slip way. An enterprising cooly *mukadum* (overseer) had covered it with a tarpaulin and was now demanding a fee of 1 anna from all who desired to see the 'god' under the canvas. To impress doubters, preliminary homage had been paid to the deity, with a sprinkling of flowers and turmeric powder, and the burning of incense sticks. It is a common practice when whales or large fish are cast up upon our coasts or taken out of the sea. The derelict becomes *'massa dev'* the fish-god and receives homage from all believers to the material gain of the presiding genius. A complete plaster mould was taken of this fish, over 2,000 lbs. of plaster being used in the process. Its cast is now exhibited in the Fish Gallery of the Prince of Wales Museum. To present the correct contours and to overcome as far as possible the distortion of form arising from a heavy body pressed against the ground, the undersurface of the fish and parts of the mid-body were remodelled. The cast is as true and accurate a representation of this rare fish as is obtainable (Plate I). The Museum is greatly indebted to Mr. J. R. Kaka

who presented this fish to the Museum, to Dr. S. B. Setna and to the Port Trust Authorities for the assistance which they gave to the Museum staff.

No. 7. On Tuesday, 16th January 1940, a whale shark (male) 18 ft. in length was landed at Chowpatty beach, Bombay. It was seen on the night of the 15th several miles out at sea, floating on the surface. The shark subsequently fouled the nets of the fishermen who secured it and hauled it ashore. (Plates IV and V).

Travancore Coast.

No. 8. Mr. R. Shankara Narayan Pillay (1929), in his list of the fishes taken in Travancore between 1901 and 1915, says that a whale shark, measuring 29 ft. in length was stranded at Trivandrum in 1900.

No. 9. Mr. Pillay also referred (loc. cit.) to the cast of a 13 ft. 7 ins. specimen, now exhibited in the fish gallery of the Trivandrum Museum. Mr. R. V. Poduval, the Curator of the Museum has since sent me the history of this shark. It was caught in fishing nets off Travancore in February 1909.

No. 10. In a letter, Mr. Poduval provides a further record of the capture of a whale shark in March 1934, when a specimen, 13 ft. in length, was captured off Trivandrum. He adds that the capture of small specimens like this is by no means uncommon.

Ceylon.

No. 11. The earliest reference to the occurrence of the whale shark in the coastal waters of Ceylon, which I have been able to find, is by Sir Emerson Tennant (1801). Writing of the export trade in sharks' fins from the gulf of Mannar, he says that the skin of the 'Basking Shark' is also sent to be converted into shagreen'. The basking shark referred to by Tennant could be none other than whale shark, as we have no evidence of the occurrence of the true basking shark (*Cetorhinus*) in these warmer seas.

No. 12. The second reference is by Capt. James Stewart (1862). In his account of the Pearl Fisheries of Ceylon he says that sharks are common and that on two occasions his attention was called to 'spotted ones' of such monstruous size as to make the common sharks at their sides look like 'pilot fish'. The 'spots' and the size again indicate that Stewart's monster sharks were whale sharks.

No. 13. Haley (1883) recorded the capture of a whale shark, 23′ 9″ long, which was taken in the fishing nets at Moratuva, 12 miles south of Colombo on the 11th January, 1883. The specimen was mounted and is now exhibited in the Colombo Museum. This is the record referred to by Day in his *Fauna* volumes, then the only example known from the Indian waters.

No. 14. The capture of a second specimen 18′ long was again recorded by Haley (1884). It was taken off Negombo, north of Colombo. The skin was sent to the British Museum and is now exhibited there.

No. 15. A third capture from Ceylon, a 14′ 5″ example, taken

Photo by *Felicitas Studio.*

Whale Shark (18 ft.) landed at Chowpatty Beach, Bombay, 16th January 1940.

Photo by *Felicitas Studio.*

off Bampalapittya (a southern suburb of Colombo), was recorded by Thurston (1894).

No. 16. To these records of the actual taking of whale sharks in the seas round Ceylon, we can now add a fourth. Mr. P. E. Deraniyagala (1936), Acting Director of the Colombo Museum, in an article on Big Game Fishing off Ceylon says, that on the 10th July, 1935 the *S. S. Katori Maru* ran into a whale shark off the Ceylon Coast. According to the Captain the specimen was 40′ long.

'It was the size of a whale, differing from that animal in shape, spotted like a leopard in a very beautiful manner. It came along under the stern of the ship during a calm, we had a magnificent opportunity of viewing it. It had a large dorsal fin, which it moved about with great rapidity when angry, in consequence of the large stones we threw down upon it, rashly for it possessed sufficient strength to have broken the rudder and to stove in the stern of the ship. Several large fish (seemingly dog-fish), about a cubit in length and upwards, were gamboling about the monster entering its mouth at pleasure and returning to the water again. The mouth was very large. Dorsal fin black or dark brown. Tail also boldly covered with brown spots like a leopard. Head, lizard-shaped.'

Mr. Deraniyagala in his letter to me says, that since his article appeared in print, there was at least one other *Rhineodon* struck by a ship in Ceylon waters, but unfortunately he had kept no record of it.

No. 17. Gudger (1940) records the ramming of a whale shark by the Dutch Ship '*Johan van Oldenbarnvelt*' about 15-18 miles off Colombo on the 24th November, 1932. Second Officer H. W. Hemmes, who reported the incident, says that:—

'The bow of the ship had pierced into the body of the shark for about three feet. The part of the ship with the tail hanging was on our starboard side and was about 25 ft. long. The fish was bleeding, but was apparently dead. When the ship got clear of the fish, the body dropped down into the water.'

East Coast of India.

No. 18. Foley's (1835) account of an unusual sea-monster in the Bay of Bengal, is, as far as I know, the earliest published reference to this shark. On a voyage to Madras, when his ship was presumably nearing port, he saw what he describes as an 'unusual sea monster' of the size of a whale, but differing from that animal in shape. He refers to its large mouth and to its body covered with brown spots like a leopard. Foley's description is sufficient to establish the identity of his monster.

No. 19. The second record from the Bay of Bengal is by Thurston (1890). He writes of a specimen 20′ long which was washed ashore at Madras in February 1889. In a subsequent publication (1894) he corrected the measurement to 22′.

No. 20. The third record from the Bay of Bengal was noted by R. E. Lloyd (1908) who reported the harpooning of a whale shark swimming on the surface at the mouth of the Hoogly, on March 23, 1908. The specimen was presented to the Indian Museum, Calcutta.

The various records of whale sharks from the coastal waters of India are shown below in tabular form. Records previously noted by Gudger (1934) are marked with an asterisk.

Records of Whale Sharks in the Coastal Waters of India and Ceylon.

West Coast of India and Ceylon

Locality	Date	No.	Reported by	Recorded by
*1. Karachi ...	...	.	...	Dr. Buist, 1850.
2. ,, ...	April, 1922 ...	1	B. D. Ashworth.	S. H. Prater.
3. ,, ...	27th March, 1937...	1	Capt. Heygate ...	,,
4. ,, ...	April, 1937 ...	1	,, ...	,,
5. Bombay ...	13th February, 1938 ...	1	Dr. S. B. Setna...	,,
6. ,, ..	1st January, 1940.	1	J. Jacobs ...	,,
7. Jaygad ...	3rd October, 1936.	1	P. V. Gogote ...	,,
*8. Travancore.	... 1900.	1	...	S. N. Pillay, 1929.
*9. ,,	February, 1909 ...	1	...	S. N. Pillay, 1929.
10. ,,	March, 1934 ...	1	S. K. Poduval ...	S. H. Prater.
*11. Mofatuva, Cyelon ...	January, 1883 ...	1	...	Hailey, 1883.
*12. Negombo, Ceylon ...	,, 1890 ...	1	...	,, 1890.
*13. Colombo ...	February, 1889 ...	1	...	Thurston, 1890.
14. Off Ceylon ...	...	...	...	Tennant, 1861.
*15. Gulf of Mannar ...	...	...	...	Stewart, 1862.
16. Off Ceylon...	...	1	...	Deraniyagala.
17. Off Colombo.	24th November, 1932 ...	1	...	W. E. Gudger, 1940.
Total, West Coast ...		14+		

East Coast of India and Ceylon

Locality	Date	No.	Reported by	Recorded by
*18. Madras ...	February, 1889 ...	1	...	Thurston, 1890.
*19. ,, ...	...	1	...	Foley, 1835.
*20. Mouth of Hoogly ...	23rd March, 1908...	1	...	Lloyd, 1908.
Total, East Coast ...		3		

A reference to the table printed above shows firstly, that practically all the recorded occurrences of whale sharks in our coastal waters are from the West Coast of India and Ceylon. During the long period over which these records extend, there are only three records from the East Coast and fourteen actual records from the West Coast of India and Ceylon, exclusive of references to specimens seen in this area.

The second fact which emerges is, that practically all the records fall between the months of January and April. In considering the distribution of the Whale Shark in our coastal waters two factors have then to be accounted for—

1. Their seasonal appearance on our coasts between January and April.

2. Their occurrence mainly on the West Coast of India and Ceylon.

To my mind, these factors provide important clues to an understanding of the movements and wanderings of these fishes. I am of opinion that the appearance of whale sharks on our coasts, during the particular season when they occur, is associated with the special abundance of their food at this particular period. Secondly that, the limitation of their range, mainly to the west coast of India and Ceylon, is due to the particular direction and movements of surface currents in the Bay of Bengal and the Arabian Sea at this period. Before taking up the evidence in support of these views, it is necessary to consider briefly the food and feeding habits of the Whale Shark.

Food of Whale Sharks.

Gudger (1915) has brought together such observations as have been made on the food of the Whale Shark. Because of its minute teeth, it was first thought that these great sharks were purely herbivorous. The large masses of algae found in the stomach led Wright (1870) to this conclusion. It is now definitely known that the Whale Shark, like the Basking Shark, feeds on plankton, strained out of the water by its peculiar gill apparatus. In some sharks, fringe-like structures, located on the pharyngeal walls, are modified to form what are known as 'gill-rakers'. In the Basking Shark and the Whale Shark, the gill-rakers are remarkably specialised to form a highly complex straining apparatus. They are closely set in a row on the inner extremity of the gill-arches, and, as they project into the inner cleft, leading to the gullet, they function effectively as a strain or sieve to food or water entering the alimentary tract. Their function is thus similar to the function of the long hair-like fringes on the baleen plates of the whale-bone whales, and as such they provide a striking example of parallelism—of the evolution of similar structures, designed to serve the same ends in totally unrelated groups of animals.

The manner of feeding of these great sharks is simple. Smith's (1849) account of the feeding habits of the Whale Shark is similar in every way to the description of the feeding habits of the Basking Shark. Both sharks swim or float leisurely with the mass of drifting plankton, and with widely open mouth, take in great quantities of water, and with it, the myriads of floating organisms it contains. On the closure of the mouth, the water is forced out through the gill-clefts, leaving the food adhering to the inner walls of the gullet and to the sieve-like gill-rakers.

During the process, masses of algae and other flotsam may be taken in. The stomach of the specimen landed at Sasson dock, Bombay, contained a mass of green algae. Kishinouye (1901) records that an oaken pole was found in the stomach of a specimen caught near Japan. The diet of the basking shark is known to consist almost entirely of zoo-plankton—of shrimp-like crustaceans, and other minute animal organisms, which swim about on the surface of the sea, and which, at certain seasons, constitute the dominating element of the plankton. Whale sharks also derive their nourishment from minute crustacean and other animal forms which, as will be presently shown, form the dominating element in the plankton of our off-shore waters when these sharks visit our coasts.

Influence of Plankton Outbursts on Movements of Whale Sharks.

Arabian Sea. Such investigations as have been made of plankton in Indian waters show, that in the Arabian Sea and the Bay of Bengal, plankton productivity is wholly dominated by the alternation of the north-east and south-west monsoon and, that plankton outbursts are far more seasonal in our seas than in most tropical waters. Writing of plankton on the Malabar Coast, Hornell and Nayudu (1923) have shown that on this coast there are two peak periods of productivity. There is a maximum production of plant forms (phyto-plankton) between May and September, in response to conditions brought about by the south-west monsoon; while a second outburst, takes place between January and February, favoured by conditions produced by the north-east monsoon. Factors favouring the first outburst are the vast quantities or organic and inorganic matter washed into the sea by the south-west monsoon floods, which bring to the surface waters the manurial elements necessary for plankton growth. Reduced salinity, occasioned by the out-flow of these flood waters, also brings about that increased stability which is favourable to plankton growth. The calm conditions which prevail during the north-east monsoon, while they again favour the growth of phyto-plankton, appear to be also favourable to the development of animal organisms (zoo-plankton), which, during this season, constitute the dominating element of the plankton. Sewell (1913) states, that a study of the plankton constituent in Indian seas leads to the conclusion that, compared with temperate seas (North-Atlantic), marine animal organisms occur at a somewhat later period, and that there seems to be a general tendency for marine organisms to have their breeding season during the cold weather rather than during the hot months of the year. The reason suggested is the disturbed conditions of the sea during the south-west monsoon. Hornell and Nayudu's investigations of the off-shore plankton on the Malabar Coast support this view and reveal the abundance of zoo-plankton during the cold weather. They write :—

'In November copepods begin to appear in much greater numbers than at any time since the preceding May, and finding an abundance of food, multiply very rapidly, with them in November, appear swarms of Napuli and a host

of other rapacious organisms to feed upon the diatoms and dino-flagellates. *This miscellaneous assemblage remains the characteristic feature of the off-shore plankton till the rains in May kill or drive away from the shore these forms and replace them with swarms of diatoms.* (Italics are mine.)

It is shown that there is clearly a super-abundance of zoo-plankton in the off-shore waters of the Malabar Coast between January and April, when whale sharks appear. Conditions on the Malabar Coast are repeated on the Bombay Coast. Through the courtesy of Dr. Lele of the Royal Institute of Science, Bombay, I had the opportunity of consulting an unpublished thesis by a Miss A. P. Gae, recording month to month plankton investigations carried out at Bombay between October 1932 and March 1934. These investigations, again reveal an abundance of zoo-plankton between January and March, enriched, the author observes, by forms not present at other seasons of the year. The investigations revealed that copepods, in particular, swarm in myriads during these months. We have no data of plankton on the Sind Coast; but the seas in the neighbourhood of Karachi must receive a considerable quantity of nutrient matter brought by the river Indus, and probably provide a rich field for the development of plant forms and the succeeding invasion of animal organisms.

These optimum conditions of food supply are repeated off the west coast of Ceylon and in certain tracts of the Arabian Sea during the North-East Monsoon. Thompson and H. Carey Gilson (1937) in their report on chemical and physical investigations in the Arabian Sea, carried out by the John Murray Expedition, express the view that, with the resumption of calm conditions in September, there is a considerable growth of phyto-plankton, particularly where upward water movements cause a renewal of nutrient-salts in the surface layers. This occurs principally near Seychelles and in the strong currents near the African coast about Lat. 1.3° N., which sweep northwards to the Gulf of Aden and the coast of Arabia. Note, that the two areas where whale sharks have been recorded from the Arabian Sea, i.e., Seychelles and the mouth of the Gulf of Aden are, as the authors show, areas of great plankton productivity. Recorded occurrences from the Straits of Babel Mandeb and the southern extremity of the Red Sea have probably a similar explanation.

Equally significant is the fact, that whale sharks have never been recorded from the Persian and Mekran coasts. This has been described by Sewell as an area of scanty plankton production—a 'desert area' as far as plankton is concerned.

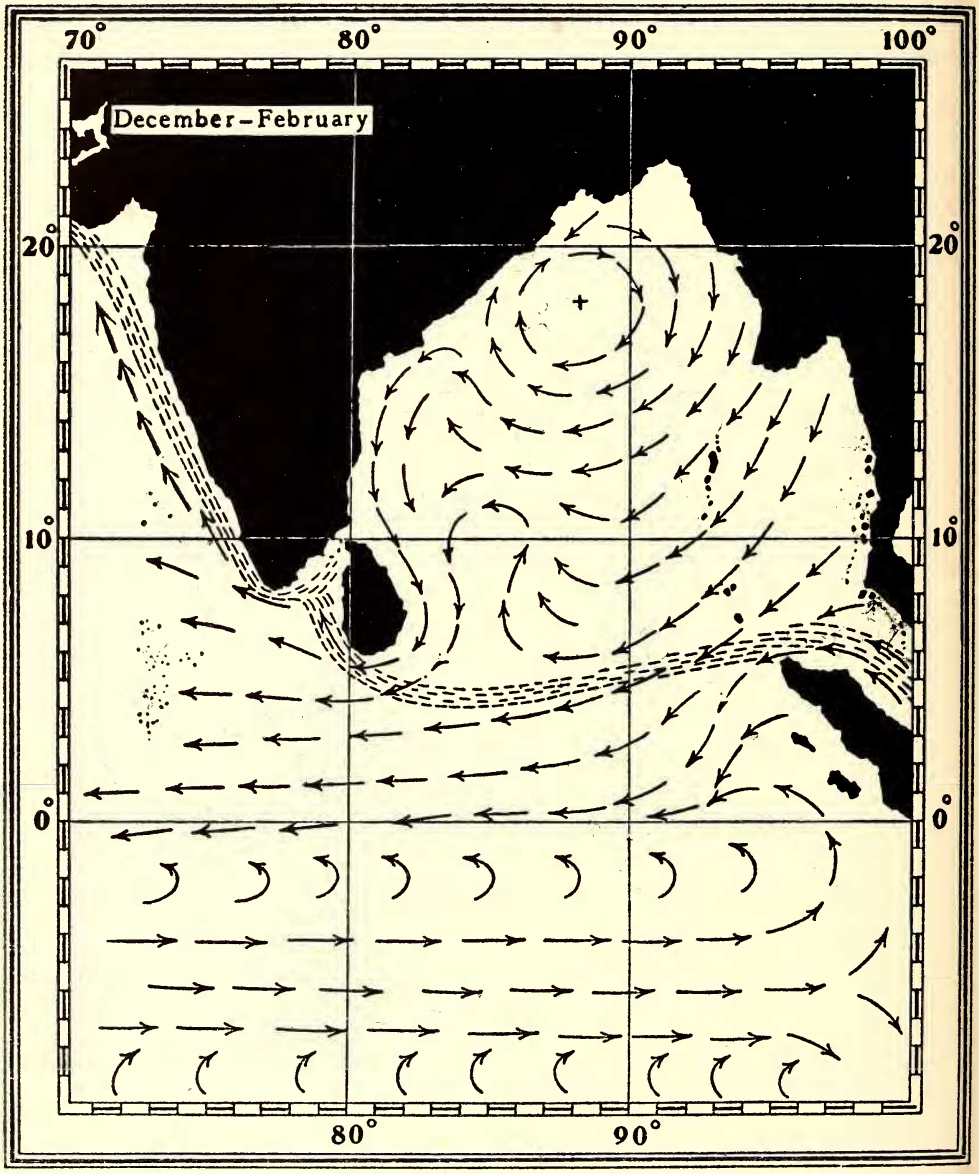
Plankton productivity in the Bay of Bengal. Menon (1931) has shown, that owing to the more limited influence of the south-west monsoon, favourable conditions for the production of plankton are not produced on the East Coast till September, when productivity commences, reaching its peak in January. From thence on there is a slight decline followed by an abrupt rise in March, which reaches its maximum in May. These phyto-plankton outbursts are, as always, followed by a rich influx of zoo-plankton, which, commencing in October, reaches maximum conditions in December, January and February and then commences to decline.

It has been shown, that between December and March, the off-shore waters of India and Ceylon provide, a super-abundant harvest of animal organisms, which become the dominating element in the plankton. The abundance of this drifting food attracts to our coastal waters, during this season, numerous surface feeding fishes, such as devil rays, sail fish, etc., and, among them, whale sharks, whose appearance on our coasts coincides with this season of plenty. There follows the second point for consideration :—If whale sharks visit our waters because of the abundant food supply why do they confine themselves mainly to the West Coast?

The Influence of Surface Currents on the movements of Whale Sharks.

Why are whale sharks so rare on the East Coast, where at the time of their migration, food conditions are as favourable as on the West Coast? Why again have they never been observed in the eastern reaches of the Bay of Bengal, or along the coasts of Burma and Tenasserim? Data provided by Sewell (1913) show that plankton decidedly increases in these waters from early November to the beginning of January, and that the plankton is very rich in animal organisms, which provide food for these sharks. Yet, during a period extending over a century, we have only three records from the East Coast, and none from the shores of Burma and Tenasserim. The explanation, I believe, is to be found in the direction and movements of the surface currents in the Bay of Bengal and along the coasts of India and Ceylon at the time when whale sharks commence their seasonal visitation to our waters. Gudger (1934), in explaining the appearance of whale sharks on the coasts of India, says that during the northern summer (i.e. June to August) there is a monsoon drift from the south-west to the north-east, which might carry whale sharks from the Seychelles Archipelago, where they are known to be permanently resident, to India. The answer to this is, that whale sharks do not visit our coasts between June and August, when the south-west monsoon is established. As shown by the records, their visits are timed between January and March, during the north-east monsoon. Sewell (1937) has indicated, that the north-east monsoon is a period when the bulk of the waters of the Arabian Sea converge upon the African coast. The movement of these sharks from Seychelles to India, at this season, would be contrary both to wind and surface currents. The sharks which visit the coasts of India during the north-east monsoon, if they follow the drift of the currents, must come to us not from the West but from the East. This, an alternative route suggested by Gudger, is the correct one. Sewell (loc. cit.) states, that with the establishment of the north-east monsoon (about December), there is a strong flow of water from the Pacific into the Indian Ocean through the Straits of Sumatra. This current known as the north-east monsoon drift, moves across the Andaman Sea and the lower reaches of the Bay of Bengal and sweeps by the south coast of Ceylon. Whale sharks, moving with this drift, would arrive off the south coast of Ceylon. From

Surface Currents of the Bay of Bengal: (after Sewell).



How whale sharks following the flow of the north-east monsoon drift and of coastal currents are brought from the Pacific to the West Coast of India and Ceylon. It will be noted that the waters which converge upon the East Coast of India and Ceylon do not come from the Pacific but from the head of the Bay of Bengal.—Route followed by fish shown in dotted lines.

this area a coastal current, which sweeps up the west coast of Ceylon, at this time of the year, would bring them to the Gulf of Mannar; from the Gulf, their progress northward, along the west coast of India, would again be aided by the coastal current, which at this season, begins to run from south to north. This north flowing coastal current would bring these sharks to the coasts of Travancore, Bombay and Sind.

The question arises, why whale sharks, if they come from the Straits of Sumatra, across the Bay of Bengal, do not first converge upon the east coast of India and Ceylon. The answer here again is to be found in the direction and movements of surface currents in the Bay of Bengal, at the time of their westerly migration. Sewell (1938), has given in some detail, an account of the movements of surface currents in the Bay of Bengal at various periods of the year. A reference to his map, which is reproduced here, will indicate that the north-east monsoon drift from the Straits of Sumatra does not flow towards the east coast of India. It runs in lower latitudes. It crosses the lower reaches of the Bay of Bengal and flows past the south of Ceylon. The waters, which impinge upon the Coromandel coast at this time of the year, (i.e. December to February), do not come from the Straits of Sumatra at all. They come from the head of the Bay, where, owing to the north-east monsoon winds, the surface waters are driven off the coasts of Burma, westwards across the Bay, to the northern section of the Coromandel coast. There, due to the rotation of the earth, and the configuration of the coast, the westward flowing current divides; one branch flows northwards, producing at the head of the Bay a cyclonical circulation; the other flows southwards along the Madras coast and the east coast of Ceylon, then, rounding the island, the current flows up the west coast of the island to the Gulf of Mannar.

Whale sharks arriving at the south of Ceylon with the north-east monsoon drift would be aided by the northward movement of this coastal current up the west coast of the Island. On the other hand, progress up the east coast of Ceylon and India, as is seen, would be contrary to the flow of the coastal currents which at this time of the year run down the east coast of India and Ceylon from north to south.

We have one record of a whale shark off the Madras coast in February, and one in March, from the mouth of the Hoogly. A directional change which takes place in the surface currents in the Bay of Bengal, late in February or early in March, may explain these records. Sewell (loc. cit.) shows, that a decided change now takes place in the directional flow of the surface currents. Between February and March, a double cyclonal circulation sets in at the head waters of the Bay of Bengal, and a current sweeps up from below Ceylon up the Coromandel coast to the coast of Bengal. The reversal in the direction of the current at this time of the year, might easily bring whale sharks up the Madras coast to the mouth of the Hoogly.

It is impossible to assume, that the movements of so powerful a fish as the whale shark are controlled entirely by the direction

of the wind and the surface currents. But knowing the nature of their food, and their peculiar feeding habits, one might say, that these sharks, like some other surface feeding fishes,—sun fishes for example,—in the calm weather which prevails in our seas during the north-east monsoon, float with the currents in order to follow more easily their drifting food. It is clear, that a general convergence upon the coasts of India, from the surrounding seas, would not explain the peculiar and limited distribution of these fish on the coasts of India. The actual distribution of whale sharks on the coasts of India, the concordance of this distribution with the direction and flow of surface currents, during the season when they appear, is clear evidence of the influence of current upon their movements. The direction of surface currents explains how these sharks, coming to us with the inflow of waters from the Pacific, converge upon the west coast of India and Ceylon; why they are so rare upon the east coast, and why they have never been recorded from the coasts of Burma and Tenasserim. The purpose of their migration is indicated in the abundance of their food in these waters at this season. It is a time of the year when these waters contain an abundance of zoo-plankton.

Seasonal Movements of Whale Sharks in other Areas.

This seasonal movement of whale sharks to the coastal waters of India is apparently repeated in other areas. It is known that whale sharks, in numbers, visit the seas off the coast of Hondo, Japan, every summer. Again, at Seychelles, it has been observed that whale sharks visit the inshore waters every year between May and August. As on the coast of India, the movement appears to be associated with the particular abundance of planktonic food in the areas visited. I have not been able to consult any papers dealing with plankton productivity in the seas off Japan. Plankton conditions in Seychelles, an area of high productivity have not been studied between May and August. Nevertheless, there is interpretative evidence to indicate that the visits of whale sharks, both to Japanese waters, and to the inshore waters of Seychelles take place during periods of high plankton productivity. Whale sharks, it has been observed, visit the Japanese waters at a time when the *bonito* fishing is at its height. At Seychelles, it was noted, that the whale sharks come inshore between May and August with numbers of horse-mackerel and great shoals of sardines and other small fry. In the Bay of California, whale sharks were again observed at certain seasons in company with tunny.

Gudger explains the association of whale sharks with bonito, tunny and horse-mackerel (*Carangidae*) as the natural tendency of these smaller fishes to shelter or follow in the wake of giant fishes. Bonito and tunny, as is well known, will even follow passing ships. Be this as it may, the point relevant to the present discussion is the reason for the presence of these carnivorous fishes in great numbers in the areas visited by these sharks. The presence of highly predatory fishes like tunny, bonito and horse-mackerel in large numbers may be connected with breeding activities; but

may also be due to an equal preponderance of sardines, herrings, mackerel, and other small fry upon which they feed; and great assemblages of these small fishes can be ascribed to the existence of a super abundance of plankton. Hornell and Nayudu (loc. cit.) have shown how the visit of myriads of sardines to the inshore waters of the Malabar Coast coincides with a peak period of plankton productivity. Gadsden (1899) shows how in the seas round Aden in April, countless millions of small fishes appear, accompanied by troops of larger fishes chiefly, tunny, and albacore, and seer, which spend their time in preying upon the smaller fry. The presence of these smaller fishes in great numbers, in the Gulf of Aden is again explained by the abundance of plankton during this period, as is evidenced by the researches of the Murray Expedition. It is probable that whale sharks and hordes of smaller fish are attracted seasonally to Japanese waters by an abundant harvest of plankton, and the *bonito,* which swarm at this season, by the abundance of their prey.

Similar circumstances account probably for the abundance of whale shark, tuna and small fish off the coast of California about which Gudger (1940) writes. He says 'The small fish go in schools and are followed by both tuna and whale sharks'. The Bay of California and the west coast of America in general is known to be an area of rich plankton productivity.

From what has been written it will be seen that seasonal visits of whale sharks take place in various parts of the world; particularly in areas, such as the coasts of India, where plankton productivity is more definitely seasonal. The basking shark (*Cetorhinus*), which recalls the whale shark in its habits, also appears to undertake similar seasonal migrations. These movements, says Norman (1937), are as yet imperfectly understood, but there appears to be a regular annual migration along the west coast of Ireland to the Western Isles of Scotland and thence northwards, the shark approaching Ireland during the spring and reaching Norway during August. It is not improbable that the seasonal movements of these basking sharks are associated with the abundance of planktonic food in the area of their wanderings during this particular time of the year. The period of their migration coincides with the great spring outburst of plankton which in these highly productive waters is generally maintained till late in the summer; the plant outburst being shortly followed by the usual invasion of animal forms. Like the Whale Shark—the Basking Shark in its quest for its food follows the course of warm surface currents, in this instance the branch of the Gulf Stream which sweeping up the west coast of Ireland flows between the Faeroe and the Shetland Islands to the coast of Norway.

Seasonal migrations for purposes of feeding, aided by the flow of favourable warm currents, thus provide an explanation of whale sharks excursions into areas far from their natural habitat. These sharks, essentially fish of warm seas, have been recorded from as far north as New York and the Seas of Japan and from as far south as the Cape of Good Hope.

We must consider the coasts of India, and all such areas where

the occurrence of whale sharks is sporadic or seasonal as areas of nominal distribution, and as such, distinct from areas, where whale sharks are permanently resident.

Centres from which Whale Sharks migrate.

A study of the occurrence of whale sharks in the various parts of the world, brought together in Gudger's valuable paper, reveals an interesting fact. These sharks have been observed all the year round only in the island-studded seas of archipelagoes, where alone they are known to be permanently resident. In the Pacific, there are three centres in which whale sharks are known to occur all the year round. These are the East Indian Archipelago, the Philippine Archipelago, and the Islands at the mouth of the Bay of California. In the Indian Ocean, there is but one such area—the Seychelles Archipelago. In the Atlantic—the island studded seas of the Carribean and the Gulf of Florida are the only areas where these sharks are recorded as being permanently resident. We can then look upon these island seas as productive centres of distribution; centres from which a certain number of whale sharks, driven by exigencies of food supply or other causes, migrate regularly or irregularly into waters where food is plentiful, aided in their migration by favourable currents flowing outward from these sheltered seas.

From the circumstances of their distribution on our coasts, we know that the north-east monsoon drift brings the whale sharks to the coasts of India. This drift is caused by an inflow of waters from the Pacific, which come *via* the East Indian Archipelago, and enter the Indian Ocean through the Straits of Sumatra. Similarly, whale sharks from the Philippines, following the Kuoro Sivo current, would be brought to the coasts of Japan. These Archipelagoes, the Philippines and East Indies, appear to be the centres from which whale sharks, aided by the flow of currents, migrate seasonally to the waters of Japan and to the coasts of India. The same factors may provide the explanation for the occurrences of whale sharks along the west coast of Mexico, Panama and Peru. These areas of nominal distribution may derive their source from the Islands of the Gulf of California, where whale sharks are known to be permanenly resident. The Mexican coastal current would provide the aegis of the southward movement.

In the Indian Ocean, the Seychelles Archipelago would be the centre from which the whale sharks, recorded from the Gulf of Aden, and the Cape of Good Hope, travelled, assisted, in the former instance, by the northward flow of the East African coastal current, and in the latter by the westward flow of the Aghulas current, which sweeps past the Cape of Good Hope. In the Atlantic, the islands of the Carribean Sea and the Gulf of Florida are apparently the centres from which whale sharks migrate periodically along the eastern coasts of the United States, or southwards to Brazil and to the West Coast of Africa, which, like the west coast of America, is a region of rich plankton productivity.

Judging from their appearance on the coast of India, it would appear that the numbers taking part in these migrations vary.

The visiting sharks are more numerous in certain years than in others.

The records of their world distribution further indicate, that these sharks, in the course of their migrations, follow the coast lines, or take advantage of chains of islands. They are not fish which roam the open seas. All records are from coastal or confined waters. It is significant that they have never been encountered in the mid ocean steamer lanes, which criss-cross the oceans of the world, where these great surface swimming fishes would not have failed to have been observed at some time or other. Gudger (1940) has brought together various records of the ramming of whale sharks by ships at sea. All these records are from coastal waters or from confined or archipellagian seas.

The fact of these seasonal movements being established, the question arises whether whale sharks, after their journeys in quest of food, return to the places from which they came. We know that whale sharks, after a temporary appearance in our coastal waters, disappear from our coasts during the disturbed conditions of the south-west monsoon. Do they spend this period of their absence roving the stormy seas? The suggestion seems unlikely, in the case of a coast hugging fish, which selects the sheltered waters of island seas for a permanent habitat. On the other hand, does this period of absence from our shore coincide with their breeding time and do these sharks return to their spawning grounds? If so, where do they breed? We know them to be permanently resident only in certain archipelagoes. Not only are they most numerous in such areas but they have been seen assembled there in great schools. Two such assemblages have been recorded from the East Indian Archipelago—one, off the coast of Papua; the other was seen, in the month of September, in the Straits of Buton. Schools have been observed also in the Philippine Archipelago. The basking shark, which, is a kin to the whale shark in most of its habits, at certain times assembles in schools of 60 to 100. Norman (loc. cit.) suggests that these assemblages may be associated with breeding. Unfortunately, we know nothing about the breeding of the whale shark or of the basking shark. The young of these fishes have never been taken. But it is safe to assume that these archipelagoes, where these sharks are most numerous, and where they are found throughout the year, are also their breeding grounds. Wanderings for food followed by assemblages for spawning is not an uncommon habit among fishes. Many species of fish with circumscribed breeding areas, after temporary wanderings for food-getting, return to their breeding grounds to spawn, and it is probable that whale sharks belong to this class and return to their spawning grounds. Gudger in discussing the place of origin of the whale shark and the mode of its dispersal, indicates the Philippine Archipelago as the centre from which the species originated—the centre from which, with the aid of favourable currents, it has extended its range and permanently established itself in various parts of the world. It would appear that this dispersal was brought about, in the first instance, by the circumscribed area of the breeding habitat and the need for finding food and space for an increasing

population, and, that wanderings, associated with food getting initiated and brought about this dispersal. The fish in the course of their wanderings established themselves wherever suitable conditions of life prevailed, i.e., in other archipelagoes. These archipelagoes in their turn became centres of productive distribution from which, at appropriate seasons and aided by suitable currents, whale sharks wander for food returning whence they came for purpose of spawning.

Local Names.

The many local names for the whale shark indicate that the fish is well known on the west coast of India and in Ceylon. In the following list an attempt has been made to give the derivation and meaning of the names used.

Sind. *Mhor*. The name *mhor* is an Arabic word meaning 'stamp' or 'seal'. Its application to the whale shark probably has reference to the spots or 'stamp-like' markings which ornament its head and body.

Bombay. *Karanj* (Marathi). Derived from Sanscrit *karanga* meaning a tree. The name is also applied in Bombay to the tree *Pongamia glabra.*, whose seeds produce a medicinal oil. I am not able to suggest a reason for the application of this name to the whale shark. Local fishermen use oil extracted from the liver of the shark for medicinal purposes. The name may have some such significance.

Bhariat (Marathi). *Bhari*: meaning great or big.

Travancore Coast. *Pulli-udoombu* (Tamil). Mr. Poduval, Curator of the Trivandrum Museum, says that the term means 'spotted reptile'; *pulli* meaning spotted; while the term *udoombu* is commonly applied to the Monitor Lizard (*Varanus*) and may have been suggested by the 'lizard-like' shape of the head.

Makara shiravu (Malayalam). Mr. Narayan Rao, Superintendent of Fisheries, Travancore, tells me that this is the most common name for this fish in Travancore. His explanation of the derivation of the term is interesting, as it provides confirmation of the seasonal migrations of these sharks to the Malabar Coast. *Makara* is the 6th month of the Malabar Era, which corresponds more or less to a period commencing with the middle of January and ending with the middle of February in the Roman Calendar. *Shiravu* means shark. Interpreted, the name would be 'January-February' shark. The period of occurrence sometimes provides the local name for a fish. On the Norwegian coast, the Piked-Whale or Lesser Rorqual (*Balaenoptera acutirostra*) is called the 'Summer Whale' because it appears more frequently during that season.

Osman Shira (Moplah). Poduval states in a letter that this is also one of the names by which the fish is known in Travancore. It is used by the Moplah fishermen.

Ceylon. *Muni-muthu-mora* (Singhalese). *Muni* means 'corpse' and *muthu* = pearl, and *mora* = shark; translated, the name would mean 'corpse-like-pearl-spotted shark'. 'Corpse-like' from the whale shark's habit of floating on the water, while 'pearl-spotted' has reference to the markings.

Photo by *Felicitas Studio*

Whale Shark landed at Chowpatty Beach, Bombay City, 16th January 1940. Close up view of head.

Frontal view of the 18ft. Whale Shark landed at Bombay, 16th January 1949. Note the enormous gape. The width of the mouth is 2ft. 8 ins.

Description.

Smith's (1849) description fully covers the external appearance of the fish. Certain details may be amplified. Reference should be made to the marked concavity of the inter-orbital space (Plate VI). It is this concavity which masks the flat wedge-shaped form of the head giving it when seen or photographed in profile a deceptive fusiform appearance. The nasal flaps are well developed and extend in a crescentic fold from the nostril to under the rim of the lip (Plate VII).

Body keels. Smith's description is as follows:—

'Sides of body irregular from two distinct longitudinal keels which commence together a little in front and considerably above the extremity of the first branchiae, and recede a little from each other as they proceed backward: of these the lowermost pursues a waved direction and at last is lost or coalesces with the keel on each side of the caudal fin. The upper again pursues a more direct course, becomes forked posteriorly, and both its branches terminate under and anterior to the dorsal fin'.

In Smith's plate of *Rhineodon typicus* (Plate 26, Illustrations of South African Zoology) the two lateral keels are well shown and the bifurcation of the upper keel is illustrated. In both specimens I had the opportunity of examining in Bombay, 3 distinct keels were present on either side of the body. A dorso-lateral keel, commencing above the branchiae and extending to below the second dorsal, and a median keel commencing anterior to the first dorsal and extending to the region of the tail. The third, the lowest keel, is the strongest and most pronounced. It commences behind the last gill-slit and reaches to the tail, coalescing there with the keels on its axis. Apparently, there is some variation in the disposition of keels. The three keels may remain distinct, or the upper and median keel may coalesce anteriorly, as in Smith's South African example.

Claspers. Both specimens stranded in Bombay were males. In the larger of the two specimens (21′ 6″) the claspers are well developed and extend backwards as far as the hind edge of the ventral. In the second specimen, a smaller shark (18′ 7″) the claspers fall short of the posterior edge of the ventrals and correspond in this respect with the description by Mulle and Henle (1841) of the 15′ example exhibited in the Paris Museum.

Colouration.

Such observations as have been made on the colouration of whale sharks reveal a certain variation, understandable in a fish of so wide a range. The data are too meagre to connect such variation with geographical distribution. But in reading the notes on colouration one is struck by the fact that in all the examples from the Central and Eastern Pacific and the Atlantic the prevailing tone of the upper surface of the body is described by various observers as brown or some shade of *brown*. This colouration is noted in examples from Cape Inubo, Japan (Kishinouye 1901), the Gulf of Panama (G. Chierchia 1884), the Gulf of California